IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Bruce Candy	Attorney Docket No.: MADDP010
Application No.: 10/577,673	Examiner: WHITTINGTON, KENNETH
Filed: April 28, 2006	Group: 2862
Title: MULTI-FREQUENCY METAL DETECTOR HAVING CONSTANT REACTIVE TRANSMIT VOLTAGE APPLIED TO A TRANSMIT COIL	Confirmation No.: 8479

DECLARATION OF BRUCE HALCRO CANDY
UNDER 37 CFR § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, Bruce Halcro Candy, declare as follows:

1. My educational background includes a Hons degree in Science (Physics & Applied Maths). Most notable academic publication includes "Class-D Audio Amplifiers with Negative Feedback", SIAM Journal on Applied Mathematics, Vol. 66, Issue 2, 2005, pp. 468-488, and an Invited Review Article: "Photomultiplier Characteristics and practice relevant to photon counting," Rv. Sci. Instrum. 56 (2), pp183-193.
2. My relevant work experience includes the following:
    a. RF Electronics designer at Codan and Barlow Communications (previously).
    b. R&D Director (1989-2008) and principle electronics designer (1989-present) of Minelab Electronics, focusing on the design of various forms of metal detectors.
    c. Principle electronics designer of Halcro (Extraordinary Technologies Audio) (1996-present), focusing on the design of audio amplifiers.

3. I am the sole inventor in the above-referenced United States patent application no. 10/577,673 ("the pending '673 application"), filed in the US as a 371 national stage patent application of PCT/AU04/01555 on April 28, 2006 and claiming ultimate priority to Australian patent application no. 2003906218 filed on November 12, 2003.

4. I am the sole inventor in the United States patent 4,942,360 ("the cited '360 patent"), filed on September 8, 1987 and issued on July 17, 1990, and claiming priority to Australian patent application PH7889 filed on September 8, 1986.

5. I have reviewed the specification, claims and prosecution history (including the currently pending claims and the outstanding office action, dated October 20, 2008) of the pending '673 application.

6. Based at least on my education and work experience as detailed above, I declare the following facts regarding how one of ordinary skill in the art at the time of my invention would interpret the term "approximately constant" as referring to the reactive transmit voltage recited in currently pending claim 1 of the pending '673 application. Please note that the term "one of ordinary skill in the art" as used below is referring to one of ordinary skill in the art at the time of my invention.

7. One of ordinary skill in the art understands that the commonly used expression "constant voltage" has quite different meanings in the time domain compared to the frequency domain and, further, one of ordinary skill in the art readily and automatically understands which meaning applies based on the context of usage of the expression.

8. One of ordinary skill in the art understands that, in the frequency domain, a "constant voltage" is usually assumed to be a constant rms value, or could be specifically specified as the absolute average, or peak, or peak-to-peak value. It is always assumed by one of ordinary skill in the art that the signal in question is A.C., and hence, changing. For example, a regulated main supply may be a "constant voltage" of 110V supplied to any reasonable load, and a meter applied to the mains will show an unchanging 110V regardless of the load, and an A.C. rms is assumed by one of ordinary skill in the art.

9. One of ordinary skill in the art understands that, in the time domain, a "constant voltage" refers to a constant, unchanging value; a "DC" voltage for a specified period or periods.

For example, one of ordinary skill in the art understands that a "constant voltage rectangular-wave" may consist of a repeating first "DC" constant voltage for a first period, followed by a second "DC" constant voltage for a second period, followed by a third "DC" constant voltage for a third period,... and thereafter the cycle repeats. Unless otherwise stated, it is assumed that the said voltage is from a source or applied.

10. So in summary, to one of ordinary skill in the art, in the time domain, a "constant voltage" is assumed to be a constant "DC" value for specified periods, and in the frequency domain, a "constant voltage" is assumed to be a constant A.C. rms value (unless otherwise specified). The term "constant voltage" usually refers to the applied voltage, which is not equal to the reactive voltage. In general, an applied voltage generates in a reactive device, "real" and an "imaginary" parts, the real parts being called resistive voltages and the imaginary part being called reactive voltages.

11. To one of ordinary skill in the art, the cited '360 patent discloses magnetic soil response in the frequency domain, and various ways to electronically cancel this signal component. Hence it assumed by one of ordinary skill in the art that the negative feedback paths, which maintain "constant reactive voltages" in the transmit coil, stabilize A.C. values at the operating frequencies, and not constant D.C. periods.

12. To one of ordinary skill in the art, in the pending '673 application, the principle is of time domain detection, and hence "constant reactive voltages" in the transmit coil means constant D.C. reactive signals for specified periods. There is no suggestion to one of ordinary skill in the art of rms values of sine-waves, for example, nor would one of ordinary skill in the art discern that there is any intention that rms values of sine waves would be assumed or included. One of ordinary skill in the art would assume that the "power sources" produce constant DC voltages, not AC voltages. That is, the switching electronics switches the transmit coil to different power sources for specified periods to produce rectangular transmit waveforms. By the use of measurements of transmit coil currents, and negative feedback loops and the choice of waveform, it is possible to produce useful periods of constant "D.C." zero reactive voltages with finite transmit coil current.

13. To one of ordinary skill in the art, a transmit coil includes an effective series resistance R, and an effective series inductance L. The inductance is modulated by ferrite particles in soils as the transmit coil is passed over the soils, and hence the ratio of the reactive transmit coil component, defined using L, and the resistive component using R, is also modulated by the soils.

14. To one of ordinary skill in the art, in the frequency domain, it is common to think of the reactive transmit coil voltage as $v = ij\omega L$, where i is the transmit coil sine-wave current at frequency ω (radians/sec), and the resistive voltage is iR. Hence the applied voltage in the frequency domain is $v = i(j\omega L + R)$, and this needs to be varied as L varies if the reactive voltage is to be held constant. The variables used to stabilize this are the phase and amplitude (of a sine wave at frequency ω).

15. To one of ordinary skill in the art, in the time domain, it is usual to think of the reactive transmit coil voltage as $v = Ldi/dt$, and again the resistive voltage as iR. Hence, the applied voltage in the time domain is $v = Ldi/dt + iR$, assuming any stray capacitance is negligible, and this needs to be varied, as L varies, if the reactive voltage is to held constant. The variables to change for stability are far more complex, as in essence the differential equation needs to be solved with the initial values included. Practical methods to do this accurately are given in the specification of the pending '673 application.

16. The table below lists what one of ordinary skill in the art would recognize. "Freq" = frequency, "Const" = constant. This table highlights the substantial difference between how one of ordinary skill in the art would interpret the '360 disclosure versus how one of ordinary skill in the art would interpret the '673 disclosure and claim terms.

Type of Transmit Signal	Sine-waves; Freq. Domain		Rectangular-waves (the waveforms in this patent application); Time Domain	
The Signal Controlled	Const applied voltage	Const reactive voltage	Const applied voltage	Const reactive voltage
Occurrence in engineering	Very common	Rare	Not very common	Extremely rare
Engineering competence required for	Routine	High competence	Routine	Highly esoteric

accuracy				
Patent		The '360 patent.		The pending '673 application.

The engineering competence required for accurately achieving time domain constant reactive voltage is labelled as "highly esoteric" in the table above. The reason is that a person of ordinary skill in the art would contemplate using a voltage-to-current negative feedback loop to change the applied current to control the transmit coil current in order to achieve constant reactive voltage. However, a person of ordinary skill in the art would not know how to implement, using this method, a loop that overcomes the problems arising from the self-resonance of the transmit coil and settles quickly enough for a desirable outcome as recited in the pending claims.

17. Using a voltage-to-current negative feedback loop to change the applied current to control the transmit coil current, in order to achieve constant reactive voltage, is impractical, as a transmit coil usually has a self-resonance frequency not much higher than the frequency corresponding to the very short time delay desirable, between the switching of the coil current and the settling of the coil current to a constant value, before the demodulation of the received signal can begin. For example, consider a coil with self-resonance frequency of 200kHz and a desired time delay of 10μs following a large back-emf period before the commencement of receive demodulation. Even with the implementation of a stable, critically damped, voltage-to-current negative feedback loop with the fastest achievable settling time, the critical damping period due to the constraints of the self-resonance of the coil is not much shorter than the 10μs time delay before the demodulation of the received signal can begin. As the transmit signal will not be well stabilized at the beginning of the demodulation, inaccuracies in analysing the received signal will occur. More esoteric (i.e., inventive) means, as described in the pending '673 application, are required for this.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these

statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both (under Section 1001 of Title 18 of the United States Code), and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Bruce Halcro Candy

20/04/09
Date